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A NOVEL SEGMENTATION TECHNIQUE USING WAVELETS AND WATERSHEDS

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ABSTRACT

In this study, a novel approach to segmenting images of trabecular bones is presented. In order to enhance fracture risk prediction, this type of imaging is obtained using microcomputed tomography (micro-CT), which assesses bone microarchitecture primarily based on measurements of bone mineral density (BMD). A bone area that may be made up of multiple separate parts on a CT picture can be used to forecast the disease osteoporosis. The multiscale morphological gradient is computed using a multiresolution representation of the picture via the wavelet transform. The markers and homogeneous zones that are retrieved using the watershed technique are determined by the coefficients of detail discovered at the various scales. The technique lessens the watershed algorithm's propensity for over segmentation and produces closed homogenous zones. The performance of the proposed segmentation scheme is presented via experimental results obtained with a broad series of images.

Keywords: novel, segmentation, technique, wavelets, watersheds.

I. INTRODUCTION

A metabolic bone disorder called osteoporosis exists [1]. Low bone mass and a micro architectural breakdown of bone structures that increases bone fragility are the hallmarks of the condition. Clinically, osteoporosis is linked to a higher incidence of vertebral bone fractures. For the management of bone illnesses like osteoporosis, an accurate clinical evaluation of bone strength and fracture risk is crucial. It refers to a significant health issue in developed nations. This illness has no symptoms and is quiet. The prevalence of osteoporotic individuals increases beyond the age of 50 [2]. A hip fracture is expensive for the healthcare system.

In the months immediately following a vertebral fracture, there is an increased risk of death and further fractures. The goal of segmenting bone structures from computed tomography (CT) scans is to separate the interior of bones (cancellous bone, space medullar) from the osseous tissue on the surface of bones (cortical bone, the trabecular network). The approximation picture of the wavelet transform at the coarsest resolution based on an adaptive threshold was also employed by Jung [10] to get an upgraded version of the image gradient.

The segmented picture is then magnified and shown at greater resolutions. To eliminate noise and certain previous information, such as the postprocessing rule, the approach needs postprocessing. A mixed morphological-spectral unsupervised image segmentation technique was put out by O'Callaghan and Bull [1,2]. This processed textured and nontextured objects in a meaningful way by using the dualtree complex wavelet transform's subbands. The segmented picture is then provided by the watershed transform. The leveling method, which Meyer [1, 2] first described, involves employing morphological filters to eliminate minute characteristics from the picture. The outcome, which has a regular form, a clean edge, and little noise, is rather pleasant. However, the micro-CT images of the trabecular bone show a low contrast edge and a significant volume.

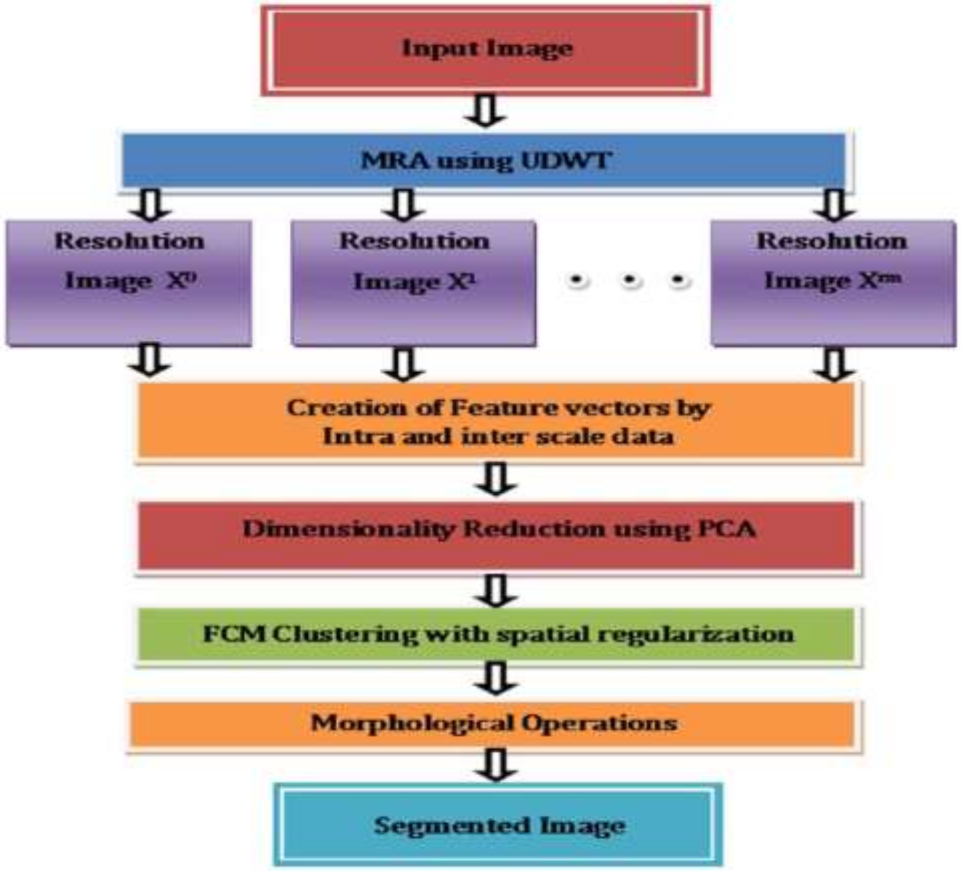

Fig.2: A novel segmentation technique using wavelets and watersheds Process

Watershed Transform and the Wavelet Transform

A morphological technique for picture segmentation is the watershed transformation [4, 5, 1, 3]. This transformation treats each gray level (or color or texture) as topographic information in accordance with a flooding paradigm, as seen in Figure 2. The basic idea is to start by looking for all of the nearby minima where holes can be punched. The model should then be submerged in a lake at a constant pace throughout time. The water level gradually increases throughout the flooding stage, gradually engulfing more and more of the image. A dam is built between two catchment basins at the locations where they collect to stop them from merging. These catchment basins correspond to various regional minima. The watershed line correlates to a number of local extremes and this built-in dam. For digital images, watershed constitutes closed contour of one-pic width [6]. Different approaches are employed to use the watershed principle for image segmentation. One of the most common watershed algorithms was introduced by Meyer [6]. This flooding process is performed on the gradient image. The implementation of this algorithm uses the hierarchical queue [5].

II. PROPOSED METHOD

The following stages might be used to summarize the suggested method. (i) Determine the stationary wavelet transform of the picture up to the specified scale (23). (ii) As illustrated in Figure 3, combine the morphological gradient magnitude observed at each scale to create a rebuilt gradient picture. (iii) Using stationary wavelet reconstruction of the sole high frequency component, localize the foreground objects, then threshold the resulting picture. (iv) Use the morphological reconstruction opening and closing operators to tidy up the margins of this binary picture. (v) Determine the ideal, appropriate markers by computing the skeleton of this preprocessed picture. Calculate the background markers (step vi). (vii) Overlay these markers on top of the gradient picture reconstruction. (viii) The most recent picture collected is provided to the watershed as input.

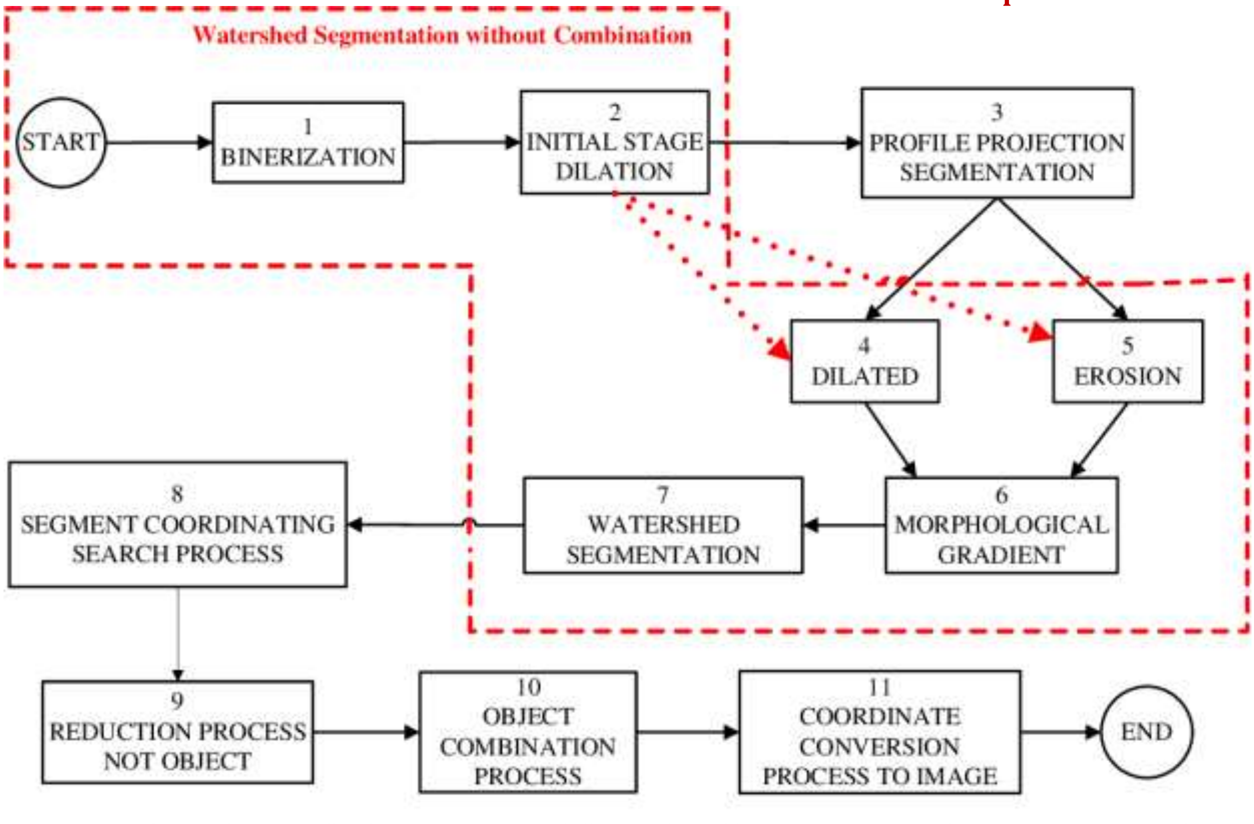

Fig.3: A novel segmentation technique using wavelets and watersheds Process.

III. EXPERIMENTAL RESULTS

A large number of micro-CT trabecular bone images of human bone biopsies collected from the femoral neck are subjected to the suggested segmentation method [2]. The outcomes are evaluated subjectively. The medullar area is effectively separated from the trabecular network. Based on the features of the trabecular bone picture, the markers are chosen adaptively. They are used to connect nearby regions since they ought to belong to the same thing and prevent the division of the desired things. Although the proposed algorithm prevents over segmentation, it preserves the sub features of the objects required for getting morphological calculation results and reconstructed 2D slices.

The suggested technique prevents over segmentation while still maintaining the subfeatures of the objects needed to get the results of morphological calculations and reconstructed 2D slices.

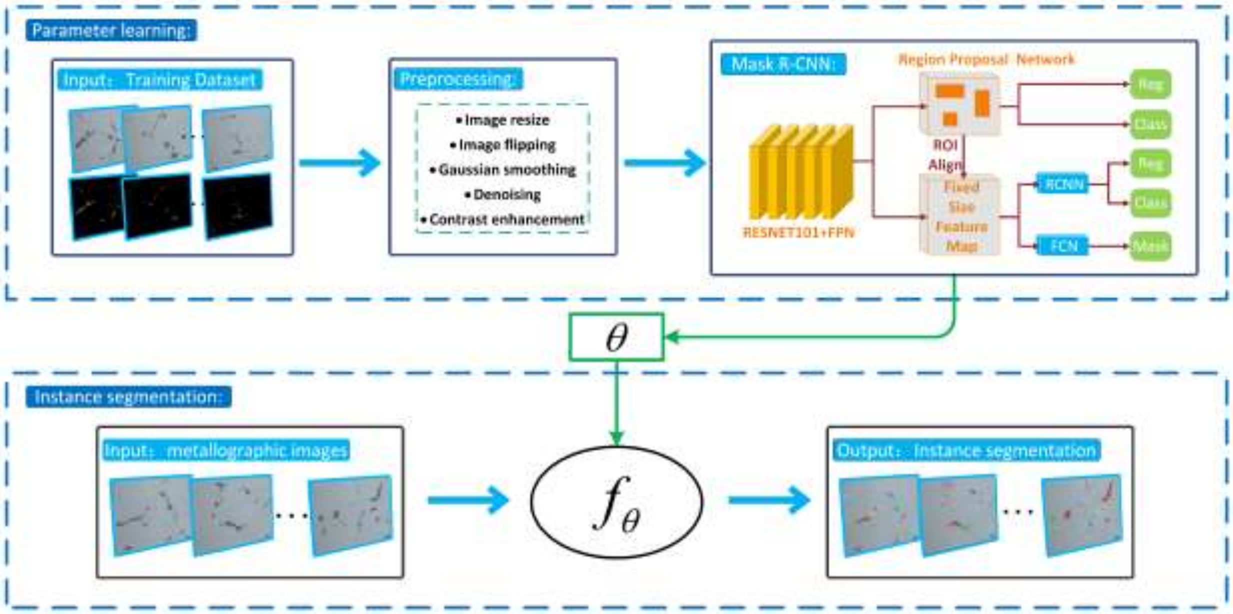

Fig.4: A novel segmentation technique using wavelets and watersheds

IV. CONCLUSIONS

An innovative technique is presented to automatically identify the trabecular network from micro-CT trabecular bone images employing morphological operations, wavelets, and watershed segmentation. The suggested approach doesn't need any help from anyone. The experiment demonstrates that the suggested method generates precise region-of-interest borders. Additionally, the algorithm is applied automatically, resulting in effective computation. Additionally, we should be aware that the segmentation outcome is dependent on the caliber of the gradient image and the appropriate markers.

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